THE NAVEL LOOP.

By BYRON ROBINSON, M.D.,

OF CHICAGO.

THE bowel and mesentery belonging to the superior mesenteric artery compose the digestive tract which extends from the flexura duodeno-jejunalis to the flexura coli lienalis (sinistra). The parts of the bowel included in this arterial blood-supply are the jejunum, ileum, appendix, cæcum, ascending and transverse colon, and the mesenteries included are the mesenterium and mesocolon transversum. The normal ascending colon of man has no mesocolon. The bowel loop supplied by the superior mesenteric artery has various designations given to it by different writers. It is called the primitive loop, the great intestinal loop, or navel loop (Nabelschleife). His proposed the name mesenterial bowel (mesenterial darm). This term of His is not apt or natural, as other portions of the bowel possess a mesentery, as the meso-sigmoid. This loop has at the anterior end the flexura duodeno-jejunalis and at the posterior end the flexura coli lienalis. It is not bordered by valves as other segments are, but by flexures. In man, it appears to me, the term navel loop is the most natural and expressive, for, so far as I am able to discover, man is the only animal in which this bowel loop, during embryonic life, protrudes at the navel and returns to the peritoneal cavity about the eighth week of gestation. Hence, we shall term the part of the digestive tube supplied by the superior mesenteric artery the navel loop. It is almost exclusively the part of the tract which is engaged in the peculiar phenomenon of rotation brought about by growth changes. It may be noted that the navel loop is divided into three very distinct portions,—viz., small intestines (jejunum and ileum) which have a well-marked mesentery; an ascending colon with no mesentery, and a transverse colon with a distinct mesentery. This loop is fixed in the middle and free at either end. Its fixations, like all other bowel attachments, are on the unmovable abdominal dorsal wall, not on the movable anterior abdominal wall. The mesentery of the navel loop begins at the flexura duodeno-jejunalis, or the lower border of the pancreas, or at the second lumbar vertebra, and it is very firmly fixed at this point, especially by the musculus suspensorius duodeni (of Treitz). This fan-shaped muscle with considerable connective tissue should rather be termed musculus suspensorius mesenterii, as both muscle and connective tissue spread out like a fan in the mesentery of the small and large bowel. From the flexura duodeno-jejunalis the mesentery passes downward from left to right, crossing immediately in front of the great blood-vessels, which lie against the vertebral column, to an uncertain ending in the right iliac fossa. This mesentery has no length at either end, but is longest in the middle, averaging about six inches. The middle seven feet of bowel possess the longest mesentery. This part is apt to be found in hernia from its elongated mesentery. From the uncertain ending of the mesenterium in the right iliac fossa the ascending colon continues upward without a mesentery. The posterior third of the ascending colon is deprived of its shining epithelial layer. It continues over the right kidney to the under surface of the liver, where it makes an obtuse bend to become the transverse colon. The line of insertion now becomes the mesocolon transversum and stretches across the body parallel to the lower border of the pancreas to the flexura coli lienalis,—*i.e.*, to the ligamentum phrenico-colicum. Thus it is seen that only two portions of the navel loop have a mesentery,—the small bowel (mesenterium) and transverse colon (mesocolon). The peculiarity of the navel loop is that in embryonic life it had a free common mesentery (mesenterium commune), but with axial rotation, changes produced by growth process, the middle portion of the navel loop (ascending colon) lost its mesentery, and became fixed to the posterior abdominal wall. The neck of this navel loop began at the root of the superior mesenteric artery, and preserves almost its original position in adults, except that the flexura coli lienalis has shifted to the left and become engaged in the folds of the great omentum, or, in other words, the ligamentum phrenico-colicum. Another peculiar phenomenon of the great navel loop is the rapid increase in length which takes place in that part of the loop known as the small intestines or jejunum and ileum, while the part of the loop known as the ascending colon and the transverse colon grows very slowly. The vigorous and extensive blood-supply to the small intestines destines this part to grow rapidly in length and to assume the chief business of digestion in man. The small intestine grows so rapidly in length that it is compelled to assume a folded or ruffled appearance. The enormous liver in early embryonic life forces the small intestines into the left iliac region. In examining human embryos from three to four months' old these phenomena can all be noted. It is to be observed that in the third and fourth embryonic months the peculiar growth changes affected by intestinal rotation are chiefly seen on the anterior or left side of the mesoduodenum. The colon ascendens loses its mesocolon mainly through the rapid growth of the kidney. The real mesoduodenum—*i.e.*, the membrana mesenterii propria—is present. It has only been deprived of its shining covering of epithelial cells on both sides, yet the anatomical mesoduodenum, the membrana mesenterii propria, the real neuro-vascular visceral pedicle is never absent. It is essential to the life of the spiral-shaped duodenum. In all the changes effected by growth and rotation of the digestive tract the cæcum never loses its complete covering. Not once in over 200 autopsies did I find the cæcum uncovered by peritoneum. We have thus been talking of a very free small intestinal mesentery of a fixed colon ascendens and a free mesocolon transversum. The mesocolon transversum is simply the continuation of the mesocolon descendens and ascendens. The blades of the mesocolon transversum divide at their insertion on the dorsal wall to receive the body and tail of the pancreas. The anomalies of the navel loop and its mesenteries are not very rare. In some over 200 autopsies I noted perhaps ten or a dozen. In the first place, it appears to me that these anomalies arise chiefly from inflammation occurring during early embryonic life, say between the eighth and sixteenth week. The process of bowel rotation has been checked by peritonitis. In fact, it appears to me that peritonitis is the chief cause in abnormalities or arrest of development in the navel loop. The first and most common anomaly of the navel loop is that of non-descended colon. The second is that of excessive descent of the colon. The third anomaly is that known as mesenterium commune. In non-descent of the cæcum one may find the cæcum at any point from the under surface of the liver to its natural position. Dr. Waite and I operated on a man of thirty for appendicitis, where the cæcum and appendix lodged immediately under the surface of the liver and the appendix ruptured near the gall-bladder. In 100 autopsies I noted four cases of non-descended cæca. So far as my observations are concerned, it appears that the arrest of the descending cæcum was due to embryonic peritonitis from careful examination of the surrounding peritoneal cicatrices. The axial rotation of the navel loop became checked by some kind of inflammatory process.

As regards excessive descent of the cæcum, I shall not attempt any explanation. However, it is a frequent occurrence to find the cæcum so excessively developed or elongated that it lies on the pelvic floor. Concerning the mesenterium commune, I have noted two complete cases in adults in 100 autopsies, but as many as four to six cases of incomplete mesenterium commune. In some twenty-five human infants and embryos I found one complete mesenterium commune once and partial several times. Whether a child will survive without any mesentery in the navel loop is very doubtful yet. Lawson Tait reports cases without a mesentery. It is doubtful whether the individual will continue existence without a peritoneum, and at this point I would call attention to cases where the bowel seems to lie in loose connective tissues. By careful separation in such cases one can soon find the old peritoneum acting as supports to the gut. I saw two such cases where the whole intestine was buried in a fine white, snow-like bed of connective tissue.

Dr. La Count suggested that it might be called senile peritonitis, yet this term would not indicate the situation. It was more like a wonderfully excessive development of connective tissue very much resembling the subperitoneal tissue. As regards the length of the navel loop, it may be found to vary widely within normal limits. We have found this loop in the adult thirty-four feet long and twelve feet long,—varying as much as twenty-two. It is common to find it vary ten to fifteen feet The part of the navel loop which especially varies is the jejunum and ileum. The next portion to vary in length is the transverse colon. The ascending colon is quite constant in length, unless the abnormality of non-descent of the cæcum or mesenterium commune occurs.

On page 519 of Meckel's pathologic anatomy several cases are mentioned of extremely short navel loop. He quotes Cabral, who observed in a forty-year-old man a digestive tract reaching from stomach to rectum without intestinal coils. The canal was barely S-formed and was four spans long, but very wide. There was no pylorus or separation between stomach and duodenum. Another case is Bellot's, quoted, where the gut was scarcely longer than the body. In Dionis' case the digestive tract reached from stomach to rectum and in almost a straight line. Meckel observed that these subjects with an abnormally short digestive tract were afflicted with very much hunger. This accords with my experience in shortening a dog's digestive tract by anastomosing the stomach to the rectum. In such cases the dog is compelled to eat much of his time to keep his body nourished, for the food passes through so quickly that little absorption can take place. I had one dog who seemed to eat nearly all the time he was awake, and yet really died of starvation, from an excessively short digestive tract. It may be observed that the colon descendens varies as the transverse does at the right side, for the hepatic flexure is a constant affair. Of course, the most numerous anomalies arise in the secondary or acquired position of the colon ascendens and its mesentery. This fact is the same whether we consider the ascending colon acquires its position through coalescence or through peritoneal displacement. The position of the colon ascendens is wholly acquired in the adult, and it is for this reason that it has so many abdominal deviations which are due to arrest of development,—in other words, the abnormality is due to the checking of axial rotation of the navel loop from adhesive peritonitis. The result is a partial or complete mesenterium commune. I have frequently noted that the lower end (say two to four inches) of the ascending colon is liable to possess a mesentery of a more or less rudimentary character. The great landmark or standard of test of the navel loop is the arteria-mesenterica super, for the superior mesenteric artery is responsible for its long intestinal tube and its vast mesentery. At a very early embryonic stage of life the artery appeared in the midst of the mesentery of the loop. Its branches spread out from it like a fan, exactly in the middle line of the body, antero-posterior. But in the adult the artery has a very different position, for its branches (vasa intestini tenuis) pass towards the left and its trunk passes behind the pancreas and in front of the duodenum. In the adult the superior mesenteric artery arises from the aorta below the cœliac axis. It passes downward, posterior to the pancreas and anterior to the transverse portion of the duodenum. As soon as it emerges from behind the pancreas the small intestinal branches (arteriæ intestinalis), ten to fifteen in number, pass to the left to supply the jejunum and ileum. Towards the end of the ileum, and beginning of the ascending colon, the ileo-colic artery passes to supply the said region. We then note an arteria colica dextra, media, and sinistra. How did this vast digestive artery acquire such a position in adult life? The artery passes behind the pancreas because the atrophying liver has dragged the duodenal loop with the pancreas in its mesoduodenum to the right. The artery passes before the lower end of the duodenum because the duodeno-jejunal flexure is fixed on the backbone near the cœliac axis by the musculus suspensorius duodeni (of Treitz). Of course, considerable connective tissue exists in this support, which I will name ligamentum mesenterii superior. Hence, when the liver drags the duodenum and mesoduodenum to the right, the pylorus, and especially the flexura duodenojejunalis being fixed, they retain their original position, while the artery itself is dragged sufficiently to the right to pass entirely to the front of the lower end of the duodenum. The final distribution of the arteriæ intestinalis is due to rotation of the jejunoileal portion of the navel loop to the left, while the colic distribution is due to acquired positions of the ascending colon and transverse colon. It might be thought that a good term for the mesentery of this loop would be the free mesentery of the arteria mesenterica superior, but as some of its original free mesentery is finally not free (ascending colon , it would not be a natural term.

In some cases the mesenterium commune of the navel loop is not only entirely free from the flexura duodeno-jejunalis to the flexura colic lienalis, but the duodenum has a free mesoduodenum and the stomach has a free mesogaster, as well as the arteria mesenterica inferior has a free mesentery from the splenic flexure to the rectum,—*i.e.*, the usual mesenterium commune, the whole bowel, is free from pylorus to rectum, as in the dog and cat, but in extraordinary cases the digestive tube is free from the cardiac end of the stomach to the rectum. The navel loop with a free mesentery or mesenterium commune is possessed of remarkable mobility. It would easily herniate from elongated mesentery. It could easily become involved in volvulus from rotation on its mesenterial axis. In regard to the mobility of the navel loop, I observed in the examination of over 100 autopsies several matters which deserve consideration. The first of which will concern the ligamentum hepato-colicum. This ligament extends from the flexura coli hepatis to the gall-bladder. It is a continuation of the ligamentum hepato-duodenale. It may not be present at all, or it may be present so extensively that it contains the gall-bladder entirely within its folds.

In cases where the gall-bladder lies between its blades it could easily conduct a gall-stone between its plates into the lumen of the colon without rupture of the peritoneum. There can be no doubt that the ligamentum hepato-colicum has saved many a victim subject to gall-stone rupture by circumscribing the invading infection by its folds and barriers. The ligamentum hepato-colicum limits the movements of the colon, and hence the mobility of the whole navel loop. How frequent the ligamentum hepato-colicum occurs is impossible for me to say, yet one sees ten to fifteen in 100 autopsies. In this group of cases the colon is held at its right flexure quite close to the liver, and the cæcum is occasionally apt to be slightly higher than usual. Another band which we examined a large number of times is a fold or band of the peritoneum, which extends from the junction of the upper or middle part of the ascending colon to the right abdominal wall. This limits the motion of the ascending colon. It appears to be due to the right lower border of the liver, and is in all respects similar to the ligamentum phrenico-colicum on which the spleen rests. I would suggest the name ligamentum phrenico-colicum dextra for this band of peritoneum. In most autopsies it is surrounded by adhesions, which seems to me to be due to the irritation produced by the liver in respiratory movements. In another set of cases there is no ligamentum hepato-colicum, and the flexure coli hepaticum is considerably removed from the liver, and, besides, is very much increased in mobility. The ligamentum phrenico-colicum dextra and ligamentum hepato-colicum may both be absent or present in various sizes. It does not appear that there is any relation between the two ligaments as to presence or absence. One may be present and the other absent. In visceral prolapse both of these peritoneal folds may be very much elongated, but the elongation does not affect the ligamentum hepato-colicum generally very much, as the pylorus descends with the gall-bladder. However, in prolapsus visceralis the ligamentum hepato-colicum dextra is the one chiefly affected by elongation. In hepatic hypertrophy of the lobus dextra the ligament may be elongated many folds, in fact, the ligament may be so elongated that it reaches over the brim of the pelvis and suspends the ascending colon almost as low as the pelvic floor. In all cases of considerable elongation due to hypertrophy of the right liver lobe we observed thickening of the ligament from chronic peritonitis in the form of deposits of white connective tissue. If there be a mesenterium commune, one is apt to find in some portion of the free loop of gut that its mesenteries have suffered in localities from old peritonitis, at least I found it to be the case in every subject in which was found a mesenterium commune. In the adult cases of mesenterium commune which came under my observation, it was impossible to learn the exact relations of the great omentum and transverse colon from the distortion and thickening due to peritonitis. However, the relation of the transverse colon and mesogaster appeared to differ little from normal. Another matter I observed in the adult subject of mesenterium commune, and that is the descending colon and the flexura coli lienalis to the sigmoid may be closely adherent, almost exactly similar to the double colon of the horse.

Again, in the examinations of cadavers one frequently observes a peculiar adhesion in the jejunum on the surface of the transverse colon, or mesocolon descendens. The most frequent anomaly of this kind is where the upper end of the jejunum is adherent from one to six inches to the lower surface of the mesocolon transversum. The bowel is adherent in a curved line in its natural loop. A short adhesion of this kind is a frequent occurrence. The adhesions of some of the upper end of the jejunum to the right surface of the mesocolon descendens is a rather rare occurrence so far as I can judge from over 200 autopsies. All these adhesions and peritoneal bands aid in limiting the motion of the navel loop. The ligamentum hepatocolicum is the most significant in curtailing the movement of the navel loop. The next band would be the ligamentum phrenico-colicum dexter, and next would be the adhesions of the upper end of the jejunum to the under surface of the mesocolon transversum, and, lastly, the adhesions found between the jejunum and mesocolon descendens. There is still to be mentioned the relation of the lower end of the ileum to the cæcum. The relation of the lower end of the ileum to the psoas muscle may be entirely altered by the amount of cæcal descent. When the cæcum fails to descend normally, the ileum generally runs upward along the psoas muscle to meet it, and the ileum is apt to have a short mesentery, and thus aid in limiting the movement of the navel loop. The many kinds of individual cases where some peculiar arrest of the development of the peritoneum and bowel have occurred from peritonitis cannot be detailed. The axial rotation of the navel loop could be checked by peritonitis at any stage with its peculiar resultant. All anomalies are generally due to peritonitis. The condition of transposed viscera must be discussed by itself. From the above remarks, it may be observed what an important *rôle* this visceral artery, the arteria mesenterica superior, plays in the development and growth of the navel loop and its mesentery.

The etiology of anomalies of the navel loop may generally be found in inflammation. Is a knowledge of anomalies of the navel loop of any value to the practitioner and surgeon? In mesenterium commune the appendix may be found in almost any locality of the abdominal cavity, and its rupture there would be confusing not only in diagnosis but in operation. Arrest of the cæcum at any point in its travels towards its home in the right iliac fossa may occur from intra-uterine peritonitis, and the rupture of the appendix in the abnormal location would confuse the diagnosis with gall-bladder troubles. An unusual volvulus could arise in mesenterium commune entirely out of the usual site, which is generally (60 per cent.) in the sigmoid flexure.